Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

GB 0225006.6

The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

1. Your reference

CTV/P101312GB

2. Patent application number
(The Patent Office will fill in this part)

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Zap Wireless Technologies Limited
Downing Park Innovation Centre
Swaffham Bulbeck
Cambridge
CB5 0NB

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

UK

4. Title of the invention

Inductive battery recharging system

5. Name of your agent *(if you have one)*

Harrison Goddard Foote

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Belgrave Hall
Belgrave Street
Leeds
LS2 8DD

Patents ADP number *(if you know it)*

14571001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
UK	0210886.8	13/5/2002
UK	0213024.3	7/6/2002

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	7
Claim(s)	0
Abstract	0
Drawing(s)	6

10. If you are also filing any of the following, state how many against each item.

Priority documents		
Translations of priority documents		
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*		
Request for preliminary examination and search *(Patents Form 9/77)*		
Request for substantive examination *(Patents Form 10/77)*		
Any other documents *(please specify)*	1	Cover letter

11. I/We request the grant of a patent on the basis of this application.

Signature

Date 28/10/2002

12. Name and daytime telephone number of person to contact in the United Kingdom: Chris Vaughan 0113 233 0100

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

INDUCTIVE BATTERY RECHARGING SYSTEM

Portable appliances are proliferating and they all need batteries to power them. Primary cells, or batteries of them, must be disposed of once used, which is expensive and environmentally unfriendly. Secondary cells or batteries can be recharged and used again and again.

Many portable devices have receptacles for cells of an industry-standard size and voltage, such as AA, AAA, C, D and PP3. This leaves the user free to choose whether to use primary or secondary cells, and of various types. Once depleted, secondary cells must typically be removed from the device and placed into a separate recharging unit. Alternatively, some portable devices do have recharging circuitry built-in, allowing cells to be recharged in-situ once the device is plugged-in to an external source of power.

It is inconvenient for the user to have to either remove cells from the device for recharging, or to have to plug the device into an external power source for recharging in-situ. It would be far preferable to be able to recharge the cells without doing either, by some non-contact means.

Some portable devices are capable of receiving power coupled inductively from a recharger, for example the Braun Oral B Plak Control toothbrush. Such portable devices typically have a custom, dedicated power-receiving module built-in to the device, which then interfaces with an internal standard cell or battery (which may or may not be removable).

However it would be convenient if the user could transform any portable device which accepts industry-standard cell sizes into an inductively-rechargeable device, simply by fitting inductively-rechargeable batteries, which could then be recharged in-situ by placing the device onto an inductive recharger.

Examples of prior art include US 6,208,115, which discloses a substitute battery pack which may be inductively recharged.

It is also known that US 5,959,433: "Universal Inductive Battery Charger System" describes a non-contact battery charging system. The battery charger described includes a single charging coil which creates magnetic flux lines which will induce an electrical current in a battery pack which may belong to cellular phones or laptop computers.

Conventional prior art for inductively rechargeable devices and batteries works as shown in Figure 1. The charger 101 drives an AC current into a coil 102 lying in the horizontal plane of the charger. This creates a vertical inductive field 103. The device 104 has a similar coil 105 which couples to the lines of flux. The charger and the device can be seen as the two, separable, parts of a conventional transformer.

This is a power-efficient solution but requires that the device be aligned quite precisely on top of the charger, in order to couple with it effectively.

An alternative solution for delivering power is the present applicant's UK patent applications numbers 0210886.8 of 13th May 2002 and 0213024.3 of 7th June 2002 (the full disclosures of which are hereby incorporated into the present application by reference), which disclose a system generating a substantially horizontal field across the surface of the charger. This is summarised diagrammatically in Figure 2, showing the charger 201 creating a horizontal field 202. A device 203 is placed on the charger and couples to its horizontal flux when the flux is aligned in a particular direction 204. Major benefits are:

- A device does not require to be precisely located and can be moved about freely over the surface of the charger in (X,Y).
- Because of this, multiple devices can be placed onto the charger simultaneously.

Additionally, and optionally, the flux 202 may be made to rotate, allowing the device to pick-up power when in any orientation, giving it a third degree of freedom - the rotation rZ as shown.

As mentioned in that application (although not claimed specifically), the device may be a "standard-sized (AA, AAA, C, D) rechargeable battery cell with magnetic material wrapped around the cylinder and windings around the cylindrical body". The present application seeks to elucidate and expand on this inventive concept.

According to a first aspect of the present invention there is provided an inductively rechargeable battery cell having a primary axis and capable of being recharged by an alternating field flowing in the primary axis of the battery, the cell consisting of:

- an enclosure and external electrical connections similar in dimensions to industry-standard batteries or cells
- an energy-storage means
- a flux-concentrating means
- a power-receiving means
- a means of converting the received power to a form suitable for delivery to outside the cell through the external electrical connections, or to recharge the energy storage means.

According to a second aspect of the present invention, there is provided a system for transferring power without requiring direct electrical conductive contacts, the system comprising:

i) a primary unit having a substantially laminar surface having at least one electrically-independent conductor that generates an electromagnetic field when a current flows therethrough and having an active area defined within a perimeter of the surface, the at least one conductor being arranged such that electromagnetic field lines generated by the at least one conductor are substantially parallel to the plane of the surface within the active area; and

ii) at least one secondary device comprising an inductively rechargeable battery or cell including at least one conductor wound about a flux concentrating means.

Preferably, the active area has a perimeter large enough to surround the flux concentrating means (e.g. a ferromagnetic core or the like) of the at least one

secondary device in at least one orientation thereof substantially parallel to the surface of the primary unit in the active area, such that when the at least one secondary device is placed on or in proximity to the active area in a predetermined orientation, the electromagnetic field induces a current in the at least one conductor of the at least one secondary device.

According to a third aspect of the present invention, there is provided a primary unit for transferring power in a non-conductive manner to at least one secondary device including at least one conductor wound about a core, the primary unit having a substantially laminar surface having at least one electrically-independent conductor that generates an electromagnetic field when a current flows therethrough and having an active area defined within a perimeter of the surface, the at least one conductor being arranged such that electromagnetic field lines generated by the at least one conductor are substantially parallel to a plane of the surface within the active area., and wherein the active area has a perimeter large enough to surround the core of the at least one secondary device in at least one orientation thereof substantially parallel to the surface of the primary unit in the active area.

According to a fourth aspect of the present invention, there is provided a method of transferring power in a non-conductive manner from a primary unit to a secondary device, the primary unit having a substantially laminar surface having at least one electrically-independent conductor that generates an electromagnetic field when a current flows therethrough and having an active area defined within a perimeter of the surface, the at least one conductor being arranged such that electromagnetic field lines generated by the at least one conductor are substantially parallel to the plane of the surface within the active area, and the secondary device comprising an inductively rechargeable battery or cell including at least one conductor wound about a flux concentrating means, wherein the active area has a perimeter large enough to surround the flux concentrating means of the at least one secondary unit in at least one orientation thereof substantially parallel to the surface of the primary unit within the active area and wherein flux lines of the electromagnetic field pass through the flux concentrating means of the secondary unit when this is placed on or in proximity to the active area as a result of the flux concentrating means offering a path of least reluctance.

The primary unit may have an integral power supply, or may be connectable to an external power supply.

Such a system is shown in Figure 3. In addition to the freedom to place the battery 302 freely in (X,Y) and optionally rotate it in rZ, relative to the charger 301, the battery can also be rotated along its axis rA while continuing to receive power.

When a user inserts a battery into a portable device, it is not easy to ensure that it has any given axial rotation. Therefore, embodiments of the present invention are highly advantageous because they can ensure that the battery can receive power while in any random orientation about rA.

Flux concentrating means:

The flux concentrating means may be arranged in a variety of ways:

1. As shown in Figure 4, a cell 401 may be wrapped in a cylinder of flux-concentrating material 402, around which is wrapped a coil of wire 403.
    a. The cylinder may be long or short relative to the length of the cell.
2. As shown in Figure 5, a cell 501 may have a portion of flux-concentrating material 502 on its surface, around which is wrapped a coil of wire 503.
    a. The portion may be conformed to the surface of the cell, or embedded within it.
    b. Its area may be large or small relative to the circumference of the cell, and long or short relative to the length of the cell.
3. As shown in Figure 6, a cell 601 may contain a portion of flux-concentrating material 602 within it, around which is wrapped a coil of wire 603.
    a. The portion may be substantially flat, cylindrical, rod-like, or any other shape.
    b. Its width may be large or small relative to the diameter of the cell
    c. Its length may be large or small relative to the length of the cell

In any of these cases, the flux-concentrator may be a functional part of the battery enclosure (for example, an outer zinc electrode) or the battery itself (for example, an inner electrode).

Issues relating to charging e.g. AA cells in-situ within an appliance:

- Cost
- Space for coils and charge circuitry will reduce capacity
- Terminal voltage could be higher than normal.
- Cells in series may behave strangely. Dealing with situations where some cells are charged, others not.
- Having to provide enough power to run the device and charge the cell.
- Circuitry/micro-circuitry for fast-charging is expensive, and if fast-charging is effected incorrectly, the cells may explode, so raising product liability issues.

Accordingly, some sophisticated charge-control means to meter inductive power to the appliance and the cell is advantageously provided. Furthermore, it becomes more important for the primary device to be able to indicate a "charged" condition, since the secondary cell or battery may not be easily visible when located inside an electrical device.

Charging in-device, or outside-device. With or without indicator, or feedback back to the pad.

Cells in packs, arranged as in normal devices (e.g. end-to-end or side-by-side).

A flat adapter which fits "over" the batteries in a device and has thin electrodes which force down between the battery electrodes and the device contacts.

Using a small standard cell inside a larger standard cell (e.g. AAA inside an AA shell).

The preferred features of the invention are applicable to all aspects of the invention and may be used in any possible combination.

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and are not intended to (and do not) exclude other components, integers, moieties, additives or steps.

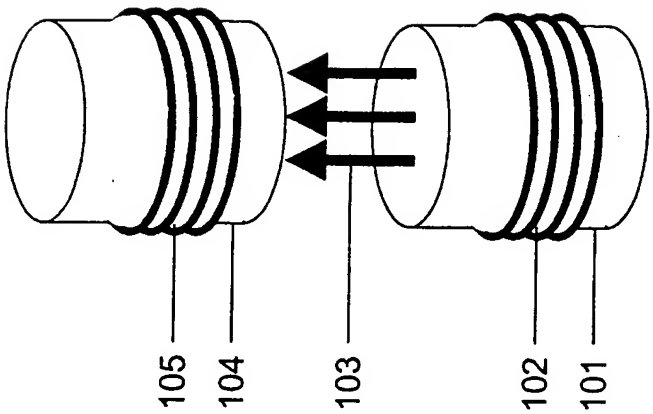

Figure 1
(Prior Art)

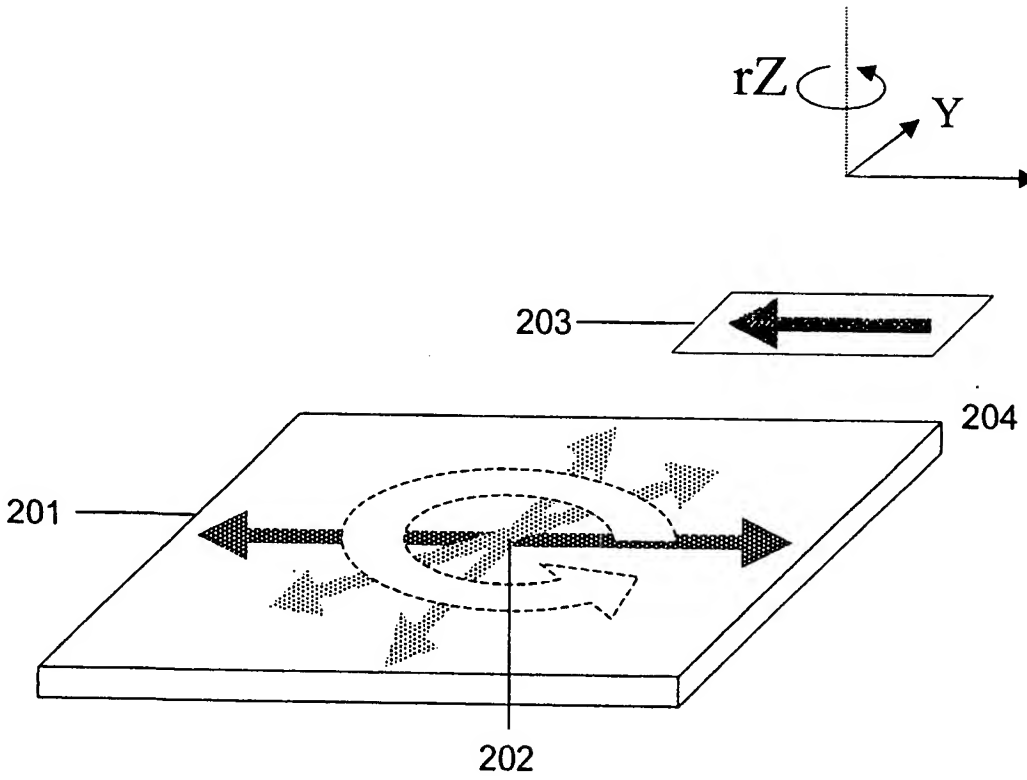

Figure 2
(Prior Art)

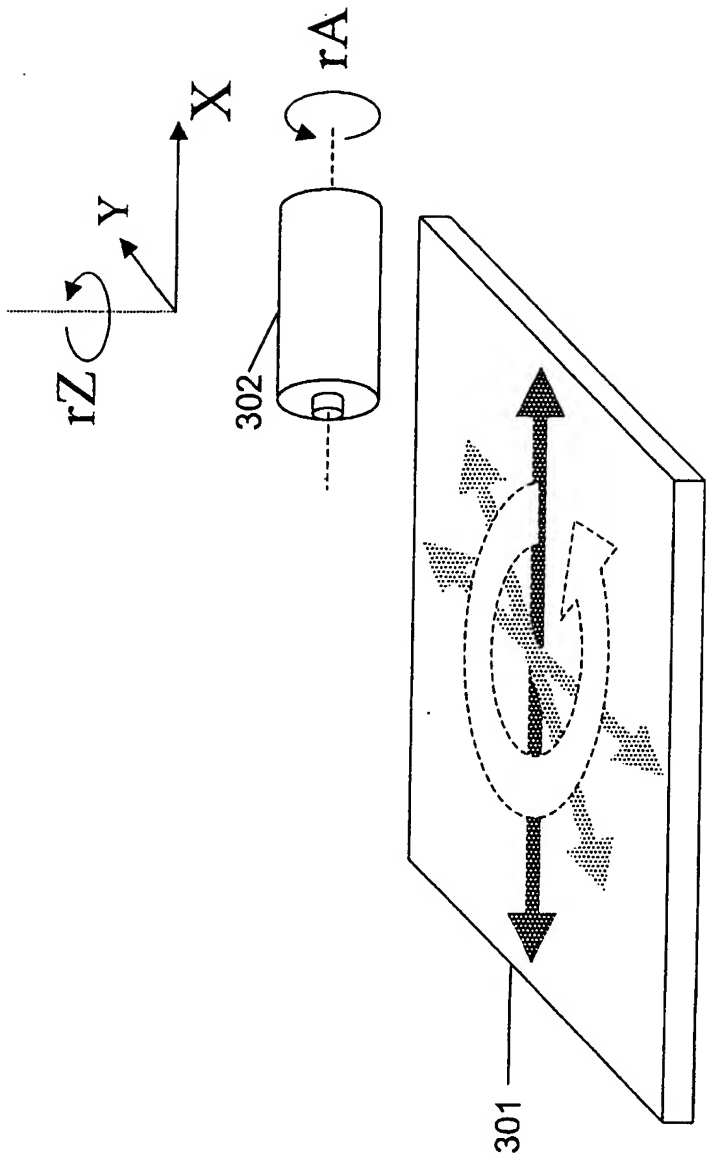

Figure 3

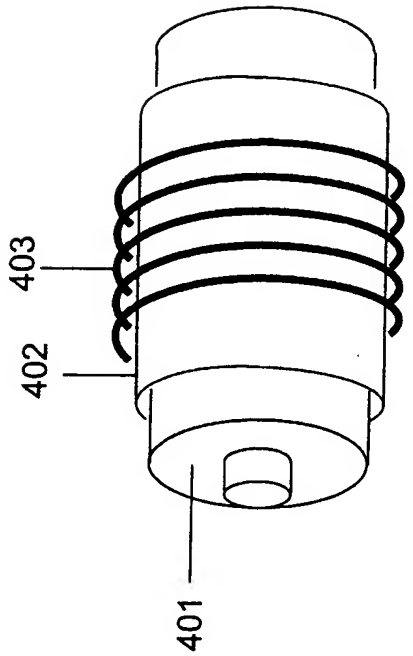

Figure 4

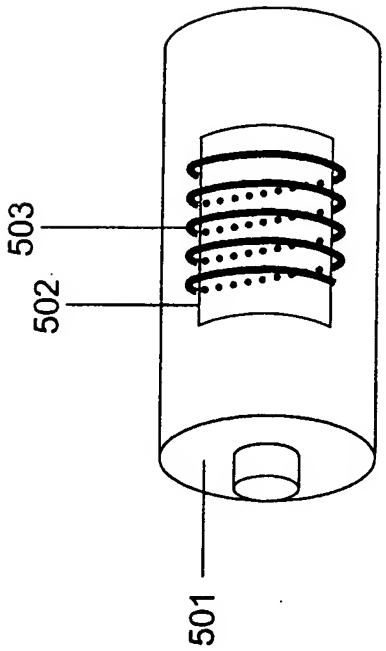

Figure 5

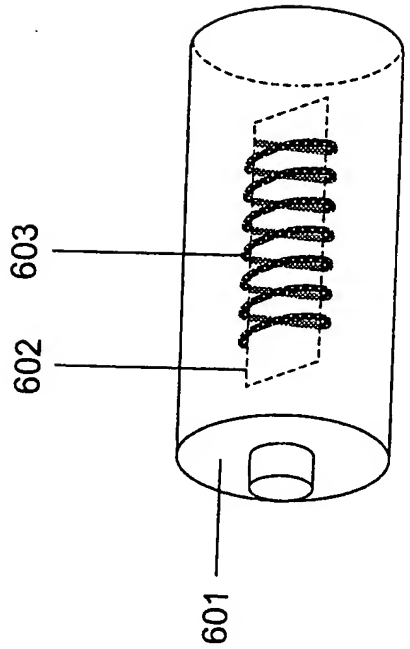

Figure 6